

Deterioration of pulmonary function with duration of exposure to silica dust in stone crusher workers

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Abstract

Background and Objectives: In stone crusher workers, one of the major health hazards is respiratory disorder. Globally, it is most common occupational disease and a major cause of morbidity and mortality. Prevalence of respiratory disease depends upon amount of silica exposure and duration of exposure. The present study was carried out to assess the effect of duration of exposure to silica dust on pulmonary function test parameters.

Methods: A cross-sectional study was carried out in stone crusher workers. Pulmonary function test were recorded on 50 subjects. Statistical analysis amongst the stone crusher workers was carried out by Analysis of Variance (ANNOVA) test.

Results: It was concluded from this study that pulmonary function test decreases as duration of exposure to silica dust increases.

Conclusion: Increased duration of exposure to silica dust may increase the risk the respiratory problems.

Keywords: Pulmonary function test, Stone crusher workers, Silica, Duration of exposure, Occupational disease.

Introduction

India is a developing country and the construction industry of India is an important indicator of the development. Due to development of physical infrastructure, massive investment is planned in this sector. The construction industry provided investment opportunities across various related sectors. As with the growing construction across India, stone crushing industry is an important industrial sector.

It is an unorganized sector and various operations like stone cutting, stone loading and crushing are carried out at the site⁽¹⁾. For various construction activities such as construction of buildings, bridges, canals, roads, hospitals etc. crushed stone as raw material is required. This sector is labour intensive as provided employment over 500,000 people involved in various activities at stone crusher site⁽²⁾.

Large quantity of heavy silica dust is produced at stone crushing site, therefore the occupational environment at the site is health hazardous. Workers exposes to silica dust may produce several diseases.

Immense amount of respirable crystalline silica dust is emitted at the crushing site, as stone contains 100% free silica⁽³⁾. The workers working in this dusty environment are at high risk of inhaling particulate materials which results in adverse respiratory problems⁽⁴⁾.

In the occupational environment, the main problem come across with respirable dust (<10 micrometer). When this fine dust enter in respiratory system on inhalation, it is considered as foreign particle and is defended against⁽⁵⁾.

Morbidity and mortality from respiratory and cardiovascular disease is highly increased on account of exposure to particulate air pollution⁽⁶⁾. The silica dust is non-irritant, odorless and does not lead to immediate effect. Dust particles on inhalation are lodged in the lung and initially there occur hyper secretion of mucus which finally leads to lung function impairment, chronic obstructive pulmonary disease, restrictive lung disease and pneumoconiosis.⁽⁷⁻¹⁰⁾

Silicosis is oldest and most alarming occupational disease which kills thousands of people all over the world. It is the major disease globally and effect workers of mining, construction and foundries⁽¹¹⁾. Scientific evidences demonstrates that working for lifetime to commonly used standard of 0.1 mg/mg³ results in radiological silicosis and lung cancer⁽¹²⁾.

Although silicosis is most common disease affiliate with silica exposure, but the current scientific research has shown other silica associated diseases like lung cancer, tuberculosis connective tissue disease and chronic obstructive pulmonary disease. Major respiratory symptoms in stone crusher workers are non productive cough, wheezing, chest pain, shortness of breath and dyspnea.

As a consequence of dust generated from quarries, pulmonary function impairment have been reported in quarry workers and severity of pulmonary function impairment is associated with type of dust, advancing age, smoking, concentration and size of silica dust in breathing zone and period of exposure⁽¹³⁾.

Therefore this study was undertaken to assess the effect of duration of dust exposure on pulmonary function parameters in stone crusher plant workers.

Material and Methods

A cross-sectional study was conducted at Stone crusher plant located at Ajmer region of Western Rajasthan. Male workers working at site were included in this study. The study was conducted on 50 quarry workers.

The stone crusher workers were grouped into 3 groups depending upon duration of exposure to silica dust as 1-5yrs of exposure(13 workers), 6-10yrs of exposure(17 workers), 11-15yrs of exposure(20 workers).

All the groups were investigated for respiratory problems, past history of respiratory disease and lung functions. Using interview technique as a tool for data collection is recorded on pre-designed performa.

Subjects with clinical abnormalities of vertebral column and thoracic cage, anemia, diabetes mellitus, hypertension, pulmonary tuberculosis, bronchial asthma, emphysema and other respiratory diseases and who had undergone abdominal or chest surgery were excluded from the study.

All the subjects were explained the purpose of study. They are also informed about the various risk and their consent is taken in this regard.

Pulmonary function tests was carried out by using computerized spirometer. Participants was thoroughly informed about the procedure and objectives and a demonstration of the test procedure was given. Subject

was allowed to sit quietly for 5 minutes and relax both physically and mentally. Clothes and belt of subject was lessened up. Subject was asked to inspire deeply as far as possible with the mouth wide open and hold the sterile mouth piece in the mouth with the lips forming a tight seal around the mouth piece and expire rapidly and forcefully through the mouthpiece. In this way, the test was performed three times and the best recording was taken. The readings for forced expiratory volume in one second (FEV₁), forced vital capacity (FVC) and computed ratio between (FEV₁/FVC) were noted.

Statistical analysis: The results were presented as Mean±SD and statistical analysis of pulmonary function test among stone crusher plant workers depending upon duration of exposure to silica dust by Analysis of Variance (ANNOVA) test.

Result

Table 1 and Fig 1 shows effect of duration of exposure to stone dust on pulmonary function test in stone crusher workers. Stone crusher workers were grouped into 3 categories depending upon duration of exposure, 1-5yrs (n=13), 6-10yrs(n=17), 11-15yrs(n=20). On statistical analysis there is significant decrease (p<0.05) in (FEV₁), (FVC), (FEV₁/FVC) parameters as duration of exposure to stone dust increases.

Table 1: Statistical Analysis of Pulmonary Function Test among stone crusher workers depending upon Duration of exposure to stone dust by ANNOVA test

| S. No. | Parameter | Mean ± SD | | | F-value | p-value | Significance |
|--------|----------------------------|----------------|-----------------|------------------|---------|----------|--------------|
| | | 1-5 yrs (n=13) | 6-10 yrs (n=17) | 11-15 yrs (n=20) | | | |
| 1 | FEV ₁ (L) | 1.84±1.18 | 0.98±0.98 | 1.01±0.97 | 3.226 | 0.0487** | ↓S. |
| 2 | FVC(L) | 2.34±0.80 | 1.69±0.59 | 1.88±0.48 | 4.284 | 0.0195** | ↓S. |
| 3 | FEV ₁ / FVC (%) | 70.27±31.05 | 42.87±33.11 | 41.15±28.48 | 4.090 | 0.023** | ↓S. |

Note: P>0.05 (N.S.)*, P<0.05 (S)**, P<0.01 (H.S.)***

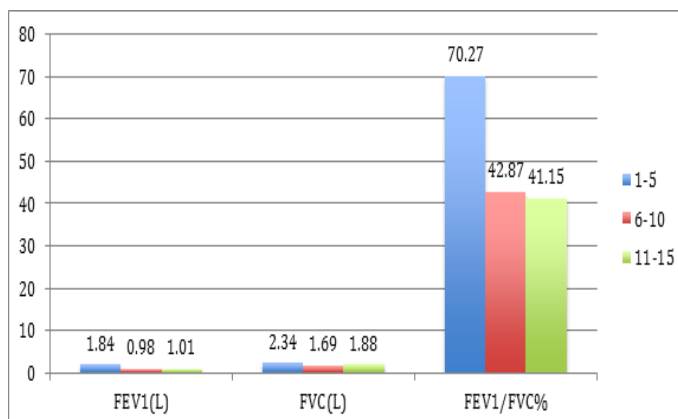


Fig. 1

Discussion

Workers working at stone crusher industry are exposed to silica dust of different concentration which on sustained exposure results in silicosis. Silicosis is most prevalent occupational disease in which irreversible fibrosis

of lung developed due to inhalation of free silica dust. The silica keeps on producing its effect even if exposure to dust is stopped.

Silica particles of 2-10 micrometer size deposited at airway bifurcation such as trachea, nasopharynx and bronchi. Small silica particles (0.2-2 micrometer) deposited on surface by sedimentation. Silica particles < 0.2 micrometer, diffuse in terminal respiratory units and contact epithelium. Thus in this way deposited silica causes irritation of respiratory mucosa which results in hyper secretion of mucus along with hypertrophy of submucosal glands in trachea and bronchi. Neutrophil also releases proteases which stimulate mucus hyper secretion. Also there occur increase goblet cells of small airways which leads to excessive mucus production^(14,15) which results in mucus plug in airway lumen. This causes obstruction in airway flow results in decrease FEV₁, FVC, FEV₁/FVC parameters.

In our study, duration of exposure to stone dust on pulmonary function test parameters (FEV₁, FVC, FEV₁/FVC) in stone crusher workers shows that there is significant decrease ($p < 0.05$) in FEV₁, FVC, FEV₁/FVC parameters as duration of exposure to stone dust increases.

Similar to our present study, V.B. Ghotkar et al⁽¹⁾, Liou SH et al⁽¹⁶⁾, Subhasini et al⁽¹⁷⁾, Bahrami et al⁽¹⁸⁾, Chattopadhyay et al⁽¹⁹⁾, Johncy et al⁽²⁰⁾ observed that pulmonary function test decreases with increases duration of exposure to stone dust.

Therefore we found that exposure to silica dust effect airway patency and prolonged exposure aggravate it and results in decreased pulmonary function test values.

Conclusion

We concluded that exposure to silica dust in stone crusher workers deteriorate pulmonary function and it is associated with duration of exposure, as duration of exposure increases pulmonary function test decreases. Workers should have proper information about health risk factors and should be provided with wet working, suitable ventilation, masks and safety glasses for protection.

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